KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
PLAINLY WORDED—EXACTLY DESCRIBED

LONDON: FRIDAY, AUG. 24, 1883.

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TRICYCLES IN 1883.

SMALL WHEELS *v.* LARGE WHEELS.

By JOHN BROWNING,

Chairman of the London Tricycle Club.

IN a tricycling journal published this week, Mr. W. T. Shaw, who is the patentee of a two-speed gearing for which we have waited impatiently for nearly a year, accuses me, though in most courteous terms, of lending the weight of my name and official position to the promulgation in KNOWLEDGE of erroneous opinions as regards the best size for the wheels of tricycles.

Mr. Shaw states, at great length, that large wheels make fewer revolutions on their axles than small ones, and also that they pass with less resistance over obstacles in their path. These facts are, of course, well known to every tyro in mechanics. Mr. Shaw argues from them that tricycles with large wheels will travel easier than similar machines with small ones.

I have no hesitation in admitting Mr. Shaw's statements and denying his conclusions. As I am accused of "propounding false theories and advocating the construction of ideal tricycles," I will confine myself in my reply to practical and well-established facts, though there is not one single sentence in the article to which I am replying to lead a reader to suppose that the writer has ever ridden a tricycle.

Let me say briefly, that large wheels are very weak as compared with small ones, unless they are made so stout as to be excessively heavy, and that this extra weight greatly reduces the speed of the machine.

The small wheels of tricycles are *not* greatly retarded by obstructions, because the rims of our wheels have soft rubber tires, and most obstructions on the roads sink into these. Neither the machine nor the rider are lifted over them. Here is a proof: the Monarch is an excellent machine, probably the best made for very rough roads, yet its driving-wheels are only 40 in. in diameter. If our roads were strewn with Kentish flints or brickbats then large wheels might be necessary.

Mr. Shaw advocates, *theoretically*, the building of "machines with driving-wheels of 56 in. *or upwards* in diameter, geared level or down to 50 in., for ordinary running, with a second speed for hill-climbing, and a steering-wheel *not less* than 24 in." Such a machine, to be fairly strong, would require to weigh from 130 lb. to 140 lb., if not more.

Now I have found that, with a machine which has 50-inch wheels, weighing from 80 lb. to 90 lb., I must gear down to 36 inches to travel easily, and my pace on a journey which takes several hours will be from five to six miles an hour.

With a machine which has 38-inch wheels, weighing from 50 lb. to 55 lb., I can gear *up* to 46 inches, and travel for a greater number of hours at the rate of from seven to eight miles an hour. In other words, wheels 12 inches larger on a machine which weighs 30 lb. more reduces my pace by two miles an hour, and the distance I can travel by 25 miles in a day. For, on the heavy, large machines, from 30 to 40 miles in a day was a hard task for me, while on the small light machines I can travel *without fatigue* from 60 to 70.

But look at the authorities I am supported by. Mr. Marriott, a partner in one of the first, if not the leading, firms of tricycle manufacturers, and our first long-distance rider, uses a machine with 42-inch wheels, geared to run as 56 inches. Mr. S. Salmon, the Secretary of the London Tricycle Club, whose experience in tricycles and tricycle riding on roads is certainly not less than that of any man in the kingdom, rides a machine which he has aptly named the "Shadow," with 40-inch driving wheels geared to 48 inches, which weighs only 46 lb. Mr. Grace, of Anerley, a most careful and thoughtful experimenter, who has several machines of various sizes, considers (I am quoting his own words) "40 inches large enough for the wheels of any tricycle."

Mr. Arthur Salmon, one of the finest riders in the London Club, who is 5 ft. 10 in. high, has for two years ridden a machine with 52 in. wheels, and which weighed 96 lb. This year he is riding a machine of the same pattern with 42 in. wheels which weighs 65 lb., and, after six months' experience, he informs me that nothing would induce him again to ride one of the larger and heavier machines. Three years ago it might have been said truly that I was urging the use of small wheels and light machines theoretically. I was perfectly aware of their disadvantages, and believed, as it is now seen correctly, that they might, in mathematical language, be neglected.

But now that manufacturers, experimenters, and riders are agreed on adopting them, Mr. Shaw must give them something more than an array of figures—he must give them good reasons drawn from riding experience before he can expect them to go back to plans which he proposes as though they were new, but which they have already tried and found wrong.

Certain results I have obtained lead me to doubt if I have yet reached the limit to which wheels may be reduced with advantage.

I shall very shortly have made for me a single tricycle, with 36-in. wheels geared to 46, which will weigh about 45 lb., and a double tricycle with 36-in. wheels, which will not exceed in weight 100 lb., and, should these be slower than machines with larger wheels, I will acknowledge it.

To conclude, I am charged with tempting makers to build machines so light that they will be unsafe. Here is my reply. At the commencement of this season, when Messrs. Humber & Co. kindly undertook to build me my 38-in. machine, which weighs about 51¾ lb., to my own specification, they stipulated that I should not ride the machine on macadamised roads. Since then they have

told me voluntarily that they are confident that the machine would carry safely a rider encycling, two stone more than myself over any roads.

"In the last few weeks I have been trying four two-speed machines, and very shortly will report on their performance.

THE BIRTH AND GROWTH OF MYTH.

By Edward Clodd.

XIV.

THE beast-fables cited in my last paper were drawn from widely-severed sources, as illustrative of ideas common to all barbarous races, concerning the community of life in man and brute.

They are thus shown to embalm the relics of a serious philosophy, and the like is true of the great mass of folk-tales of which they are a branch. The connection of the two is, indeed, manifest in the group of which "Beauty and the Beast" is a well-known example, in which the husband or wife is of fair human form by night and a hideous monster by day, until freed from the sorcerer's enchantment. Such tales have not fallen in the East to the low level which they have reached here, because they yet accord in some degree with extant superstitions in India, whereas in Europe they find little or nothing to which they correspond. But, dismissing these, we will deal with a group of stories culled from various collections, the leading idea of which is the dwelling apart of the soul or heart, as the seat of life, from the body, in some secret place, as in an egg, or a necklace, or a flower; the destruction of the soul involving that of the body.

In the Norse tale of "The giant who had no heart in his body," the monster turns six princes and their wives into stone, whereupon the seventh and only surviving son, Boots, sets out to avenge their fate. On his journey he saves the lives of a raven, a salmon, and a wolf, and the wolf, having eaten his horse, compensates Boots by carrying him to the giant's castle, where the lovely princess who is to be his bride is confined. She promises to find out where the giant keeps his heart, and by blandishments and divers arts known to the fair sex both before and since the time of Delilah, she worms out the secret. He tells her that "far, far, away in a lake lies an island; on that island stands a church; in that church is a well; in that well swims a duck; in that duck is an egg; and in that egg there lies my heart, you darling!" Boots, taking fond farewell of the princess, rides on the wolf's back to the island. Then the raven he had befriended flies to the steeple and fetches the key of the church; the salmon, in like return for kindness, brings him the egg from the well where the duck had dropped it.

Then the wolf told him to squeeze the egg, and as soon as ever he did so, the giant screamed out. "Squeeze it again," said the wolf; and when the prince did so, the giant screamed still more piteously, and begged and prayed so prettily to be spared, saying he would do all that the prince wished if he would only not squeeze his heart in two. "Tell him if he will restore to life again your six brothers and their brides, you will spare his life," said the wolf. Yes, the giant was ready to do that, and he turned the six brothers into kings' sons again, and their brides into kings' daughters. "Now squeeze the egg in two," said the wolf. With questionable morality, doing evil that good might come, Boots squeezed the egg to pieces, and the giant burst at once.

Some interesting variants of this story are given by Mr. Ralston in his "Russian Folk-Tales," in which Koshchei is the counterpart of the giant, his death being brought about by the destruction of the object in which his soul is hidden. In one story he is killed by a blow on the forehead inflicted by the mysterious egg—that last link in the magic chain by which his life is darkly bound. In another version the fatal blow is struck by a small stone found in the yolk of an egg, which is inside a duck, which is inside a hare, which is inside a stone, which is on an island. In another variant, Koshchei attempts to deceive his fair captive, pretending that his "death" resides in a besom, or in a fence, both of which she adorns with gold in token of her love. Then he confesses that his "death" really lies in an egg, inside a duck, inside a log which is floating on the sea. Prince Ivan gets hold of the egg, and shifts it from one hand to the other. Koshchei rushes wildly from side to side of the room. At last the prince breaks the egg, and Koshchei falls on the floor and dies.

In Serbian folk-tale the strength of a baleful being who had stolen a princess lies in a bird which is inside the heart of a fox, and when the bird was taken out of the heart and set on fire, that moment the wife-stealer falls down dead, and the prince regains his bride. In Bohemian, Gaelic, Greek, Finnish, as also among the Hottentot and Samoyed folk-tales, the same incident occurs of an external soul, generally hidden in an egg, the breaking of which ends the life of giant or other monster. In the "Arabian Nights" the Jinni's soul is enclosed in the crop of a sparrow, and the sparrow is imprisoned in a small box, and this again in seven other boxes, which are put into seven chests, contained in a coffer of marble, which is sunk in the ocean that surrounds the world. Seyfel-Mulook raises the coffer by the aid of Suleyman's seal-ring, and having extricated the sparrow, strangles it, whereupon the Jinni's body is converted into a heap of black ashes.

The most venerable form in which we possess the myth of a man's soul outside his body comes to us from the valley of the Nile, but before narrating this we must seek in the "storied East" the close parallels to the folk-lore of the Western Aryans. As in the Rig-Veda we are in certain respects nearer to the older forms of the parent language of the Indo-European peoples, so in the folk-tales of Bengal and the Deccan we are nearer the earliest forms of the fireside stories of both east and west.

In the story of "Punchkin" given in Miss Frere's "Old Deccan Days," a Rajah has seven daughters, and his wife dying when they were quite children, he marries the widow of his prime minister. Her cruelty to his children made them run off to a jungle, where seven neighbouring princes, who were out hunting, found them, and each took one of them to wife. After a time they again went hunting, and did not come back. So when the son of the youngest princess, who had also been enchanted away, grew up, he set out in search of his mother and father and uncles, and at last discovered that the seven princes had been turned into stone by the magician Punchkin, who had shut up the princess in a tower because she would not marry him. Recognising her son, she plotted with him to feign agreement to marry Punchkin if he would tell her where the secret of his life was hidden. Overjoyed at her yielding to his wish, the magician told her that it was true that he was not as others.

Far, far away, hundreds of thousands of miles from this, there lies a desolate country covered with thick jungle. In the midst of the jungle grows a circle of palm-trees, and in the centre of the circle stand six chattees full of water, piled one above another; below the sixth chattee is a small cage which contains a little green parrot; on the life of the parrot depends my life, and if the parrot is killed I must die." But, he added, this was not possible, because thousands of genii "surround the palm-trees, and kill all who approach the place."

The princess told her son this, and he set forth on his journey. On the way he rescued some young eagles from

a serpent, and the grateful birds carried him until they reached the jungle, where, the genii being overcome with sleep by the heat, the eaglets swooped down. "Down jumped the prince; in an instant he had overthrown the chattees full of water and seized the parrot, which he rolled up in his cloak," then mounted again into the air and was carried back to Punchkin's palace. Punchkin was dismayed to see the parrot in the prince's hands, and asked him to name any price he willed for it, whereupon the prince demanded the restoration of his father and his uncles to life. This was done; then he insisted on Punchkin doing the like to "all whom he had thus imprisoned," when, at the waving of the magician's wand, the whole garden became suddenly alive.

"Give me my parrot!" cried Punchkin. Then the boy took hold of the parrot, and tore off one of his wings; and as he did so the magician's right arm fell off. He then pulled off the parrot's second wing, and Punchkin's left arm fell off; then he pulled off the bird's legs, and down fell the magician's right leg and left leg. Nothing remained of him save the limbless body and the head; but still he rolled his eyes, and cried, "Give me my parrot!" "Take your parrot, then," cried the boy, and with that he wrung the bird's neck, and threw it at the magician, and as he did so, Punchkin's head twisted round, and, with a fearful groan, he died. Of course, all the rest "lived very happily ever afterwards," as they do in the plays and the novels.

In the story of "Sodewa Bai," the Hindu Cinderella, the heroine's soul is contained in a string of golden beads. and in the Bengali tale, "Life's Secret," a Rajah's favourite wife gives birth miraculously to a boy, whose soul is bound up in a necklace in the stomach of a boal-fish. In both instances the jewels are stolen, and while they are worn by the thieves, prince and princess alike are lifeless, whilst with the recovery of the jewels, life returned to each.

The family likeness of these Indian folk-tales to those given above is explicable on no theory of borrowing, and finds its sole and rational explanation in the possession of a common stock of folk-lore by the several ancestors of the Indo-European races. As Sir G. W. Cox remarks, "the substantial identity of stories told in Italy, Norway, and India can but prove that the treasure-house of mythology was more abundantly filled before the dispersion of the Aryan tribes than we had taken it to be."

The Egyptian tale of the "Two Brothers" is of great value on account of its high antiquity, and, moreover, specially interesting as recording an incident similar to that narrated in the life of Joseph. It is contained in the d'Orbiney papyrus preserved in the Bibliothèque Impériale, the date being about the fourteenth or fifteenth century B.C.

There were two brothers, Anepou and Satou, joined as one in love and labour. One day Satou was sent to fetch seed-corn from Anepou's house, where he found his brother's wife adorning her hair. She urged him to stay with her, but he refused, promising, however, to keep her wickedness secret. When Anepou returned at even, she, being afraid, "made herself to seem as a women that had suffered violence," and told him exactly the reverse of what had happened. Anepou's wrath was kindled against Satou, and he went out to slay him; but Satou called on Phra to save him, and the god placed a river between the brothers, so that when day dawned Anepou might hear the truth. At sunrise Satou tells his story, and, mutilating himself, he says that he will leave Anepou and go to the valley of the cedar, in the cones of which he will deposit his heart, "so that if the tree be cut, his heart would fall to the earth, and he must die."

Space forbids further outline of the venerable story, which finally ends with the reconciliation of the two brothers.

For us the value of these folk-tales lies in the relics of barbaric notions concerning the nature of man and his relation to external things which they preserve. They have amused our youthhood: they may instruct our manhood. Not if we go to the solar mythologist for their interpretation. We shall learn from Sir G. W. Cox that "the magician Punchkin and the heartless giant are only other forms of the Panis who steal bright treasures from the gleaming west," that "Balna herself is Helen shut up in Ilion . . . the eagles the bright clouds,"* and from Professor de Gubernatis that the duck is the dawn and the egg the sun.

These venerable tales have a larger, richer meaning than this, expressive of the wonder deep-seated in the heart of man. Like the beautiful prisms of topaz and beryl revealed when a "drusy" cavity in granitic rock is broken open, they hold within them the crystallised thought of the past. The soul existing apart from the body, whether in bird or casket, and determining its fate, is the relic of barbaric belief in one or more entities *in* the body, yet not *of* it—a belief extant among tribes still uncivilised, and surviving in unsuspected forms among more advanced races.

SEA ANEMONES

AT THE FISHERIES EXHIBITION.

By Thomas Kimber.

III.

(*Continued from page* 90.)

"Full many a flower is born to blush unseen,
And waste its fragrance on the desert air;
Full many a gem of purest ray serene
The dark unfathomed caves of ocean bear."

THE adult animal dwells in the deep sea beyond low-water mark, and in Torbay and Weymouth Bay is found in great abundance, at depths varying from three to thirty fathoms. The young, in large numbers, are met with between tide-marks in pools, or suspended from the roofs of rocky hollows, like white nipples, each with a dependent globule of water, resembling a dew-drop. These young dianthuses change their position spontaneously, and remove into deep water as they approach maturity. They are rarely ever met with between tide-marks exceeding, when in button form, an inch in diameter. In early youth the characteristic convolutions of the disk, with its feathery aspect, are not displayed; and incautious observers are very liable to mistake a young dianthus for an anemone of another species. Both Dalyell and Gosse confess to this error of judgment.

This species is gregarious; the dredge and the trawl constantly bring up clustered groups, and sometimes the clusters are very numerous. A trawler (see Gosse, "Action," p. 21) brought into Torquay a board, two feet long and one foot broad, on which were crowded between four and five hundred specimens of A. dianthus. "What was curious was that all one side of the board were white, all on the other orange."

The reproduction of this anemone by spontaneous division is very common. When it chooses to change its position it does so by moving the base slowly—too slowly,

* "Mythology of the Aryan Nations," Vol. I., p. 140, *n*.

indeed, for the eye to appreciate its movement; yet if its course be, as it usually is, from the bottom to the top of the glass front of the tank, it will be marked out plainly by the track left behind. Minute fragments of the base are seen to adhere to the glass, which very soon contract into a rounded form, and begin to grow tentacles round a central mouth, and in time the minute creatures equal in size the elder original. This increase by separation of parts is analogous to the multiplication of plants by cuttings. In both cases the colour remains unchanged; whereas, in the propagation of plants by seeds and of anemones by real germs, the colour of the new production is arbitrary and inconstant.

Sometimes the irregular fragments, torn, as it were, from the base, in contracting make two circular forms united by a filament, and as the contraction continues, the uniting link becomes a fine thread, and finally breaks, when two individual anemones are formed. In this manner monstrosities probably have their origin; the connecting thread is not broken, and the two individuals grow up in contact, or united together, and an individual appears with one body and two disks.

At the present moment, in tank No. 10, two very handsome anemones, a white and a buff dianthus, are attached to the front glass. They are nearly equal in size, and correspond fairly well in dimensions to Figs. 1 and 2 in the preceding article (page 89), except that their bodies are much shorter than in Fig. 2, which is possibly in consequence of their position.

A favourite practice with dianthus is to mount the side of the tank as high as the edge of the water, and to remain there protruding its column horizontally, and distending its frilled disk so that the air and water are equally and mutually in contact with opposite parts of the base column and disk.

No British anemone is more hardy, or more readily accommodates itself to confinement, than dianthus; neither is it what is termed a coy or a shy creature. It freely expands and appears in flower during daylight.

Still, it must be remembered that its natural habitat, and that of all the sea anemones, is in the "dark caves of ocean."

Bearing this fact in mind, Mr. Gosse has very sagaciously pointed out the best way to make sure of seeing a tank of anemones under the most favourable possible circumstances, and at a time when all its occupants will be most likely to display the full beauty of their gorgeous bloom.

His advice to the benevolent reader is that he should adopt Sir Garnet Wolseley's *beau stratagème*, so successfully executed at Tel-el-Kebir against the Egyptians; which, of course, is to steal a night-march upon your enemy and catch them napping. His words are:—"Visit your tank with a candle an hour or two after nightfall."

Some individuals of this species are voracious feeders; they swallow and partially digest bits of raw mutton and fish once in two or three days, and grow wonderfully larger and handsomer after each meal. The portions of food eaten, so to speak, by anemones are retained for several hours—sometimes days—and then vomited along with true germs and egg-germs in many of the species.

Anemones are fed according to their appetite upon raw beef, mutton, fish, oyster, mussel, cockle, limpet, &c. A small fragment is held within reach of the feelers or placed upon the disk. All the varieties which feed freely soon degenerate in size and colour if they do not receive their supplies regularly.

An American dianthus—and in accordance with the eternal fitness of things the biggest ever seen—is reported upon and figured in the great American work edited by J. W. Dana,* as follows:—*Actinia Paumoteusis.* From the coral reefs Paumotu Archipelago.

Smooth exterior, 6 in. thick at middle, above very widely dilated (12 in.), tentacles numerous, covering the larger part of the disk, yellowish-white, tipped with lake, and marked with eight or nine transverse lines; mouth but little prominent (*J. Drayton*).

This species was truly magnificent when seen in the water, the disk expanding at least a foot in diameter, densely covered with tentacles, the margin undulating so as to form numerous lobes, each of which had the appearance of being a separate actinia, the whole resembling a beautiful bouquet (*J. P. Couthony*).

PRETTY PROOFS OF THE EARTH'S ROTUNDITY.

CHIEFLY FOR THE SEASIDE.

By Richard A. Proctor.

(*Continued from page* 102.)

I HAVE received from a number of readers questions relating to the determination of the actual amount of depression of the earth's surface from a tangent line at any point at given distances from the point of contact. In particular some perplexity seems, strangely enough, to be occasioned by statements as to the distance at which lighthouses of given heights have been seen from ships at sea.

The actual depression of the earth's globular surface, below a true tangent, is almost exactly 8 inches at a mile's distance from the point of contact; four times this or 2 ft. 8 in. at two miles' distance; nine times 8 in. or 6 feet at three miles' distance; and so on,—the depression increasing as the square of the distance. Thus if PABC (Fig. 11) is a part of the earth's surface, *abc* a tangent line at P, *a*A, *b*B, *c*C vertical lines to the surface PABC; then if P*a*=*ab*=*bc*=1 mile, A*a*=8 in.; B*b*=4A*a*=2 ft. 8 in.; C*c*=9A*a*=6 ft. &c.

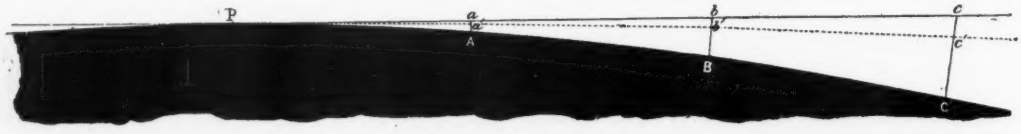

Fig. 11.

But the optical horizon line, tangent at P, has a slightly curved course as P*b'c'*, owing to the refractive effects of the atmosphere. Though this curvature A*a*, B*b*, C*c* are each reduced by about one-fifth so that

A*a'*=6$\frac{2}{5}$ in.; B*b'*=4A*a'*=2 ft. 1$\frac{3}{5}$ in; C*c'*=9A*a'*=4 ft. 9$\frac{3}{5}$ in. &c., nearly enough. Refractive effect varies, sometimes

* "Zoophytes," Vol. VII., p. 141. A fine copy of this really splendid work, "Presented by the United States Congress to the Government of Great Britain," can be consulted in the British Museum Reading-room.

diminishing the geometrical depression by as much as a fourth or even more, sometimes by barely a sixth or even less. For ordinary rough calculations it suffices to put 6 in. for the optical depression due to one mile.

It is easy to deal with any problem requiring us either to find the distance of the sea-horizon for any given height of the eye above the sea level, or *vice-versâ* to determine what is the height of the eye when the sea horizon lies at a given distance. For, if d is the optical depression for one mile, D the depression in inches at a distance of n miles, we have $D=n^2d$; $n=\sqrt{\frac{D}{d}}$; and d may usually be taken equal to half a foot.

Suppose, for instance, the problem—*If the eye is* 20 *feet above the sea level, how far off is the sea horizon?*

Here we have, taking a foot as the unit of length, and $d=\frac{1}{2}$ ft.

$$n=\sqrt{20\div 2}=\sqrt{40}$$
$$=6\tfrac{1}{3} \text{ approximately}$$

If we had put $d=6\frac{2}{5}$ inches, we should have had, taking the inch as the unit of length,—

$$n=\sqrt{240\div\frac{32}{5}}$$
$$=\sqrt{\frac{1200}{32}}=\sqrt{37{\cdot}5}$$

or $n=6\frac{1}{9}$ approximately.

Again, suppose the problem,—*If the sea horizon lies* 20 *miles away, how high is the eye above the sea level?*

Here we have, taking the inch as the unit of length, and $d=6$ inches,

$$D=(20)^2\ 6 \text{ inches}$$
$$=200 \text{ feet.}$$

If we put $d=6\frac{2}{5}$ inches, we get instead

$$D=(20)^2\frac{32}{5} \text{ inches}$$
$$=80\times 32 \text{ inches}$$
$$=2560 \text{ in.}=213 \text{ ft. } 4 \text{ in.}$$

Let us next take a class of problem scarcely less simple, but of more general use.

In a letter recently addressed to the Daily News, *Prof. Tyndall says that going out in the steam yacht the* Princess Alexandra *to a distance of* 21 *miles from the Galley Head Lighthouse, the earth's rotundity coming between them and the shore, the light "dipped" beneath the horizon. Supposing the eye of the observer to have been* 16 *feet above the sea-level, what is the height of the Galley Head Light above the same sea surface?*

The way in which Parallax and his followers solve the problem is as follows. For 21 miles the depression of the sea surface below a tangent-line is 8 in. multiplied by the square of 21, or 441—*i.e.* 294 feet. Hence the beacon light "must have been" (here I quote one of those worthies) "294 feet above the sea level minus the eight or ten feet of the steamer's deck." Taking 16 feet for the height of the eye above the sea, this would give 294—16 or 278 feet for the height of the Galley Head Light which is known not to be half that height above the sea level.

Let us see how the problem should be dealt with, taking first the 8 inches per mile which corresponds to the depression of a geometrical tangent line.

Let L P O (Fig. 12) be the earth's surface, l the light, o the place of the observer's eye, l P o touching L P O at L; let L l be the height of the lighthouse, O o the height of the observer's eye above the sea, or 16 ft. Then

$$P O=\sqrt{16\div\tfrac{2}{3}}=\sqrt{24}=4{\cdot}9 \text{ nearly}$$
$$\therefore\ lP=21-4{\cdot}9=16{\cdot}1 \text{ miles}$$
$$\text{and } L\,l=8\times(16{\cdot}1)^2 \text{ inches}$$
$$=173 \text{ feet,}$$

rather less than 278 feet.

But putting $d=6$ in. we reduce the height L l still more remarkably. For then we have

$$Po=\sqrt{16\div\tfrac{1}{2}}=\sqrt{32}=5\tfrac{2}{3} \text{ nearly enough}$$
$$\therefore\ lP=21-5\tfrac{2}{3}=15\tfrac{1}{3} \text{ miles}$$
$$\text{and } Ll=6\times(15\tfrac{1}{3})^2 \text{ inches}$$
$$=1{,}411 \text{ inches}=117 \text{ ft. } 7 \text{ in.}$$

Yet honest Parallax and his erudite followers quietly substitute 278 feet or thereabouts as the true height of a light seen 21 miles over a sea horizon by an eye 16 feet above the sea level! And one of them has just, with the manners of his tribe, told Prof. Tyndall he has wilfully lied in the matter. Such is the honesty of some flat-earth men; such the ignorance of others; and such the polite suavity of them all.

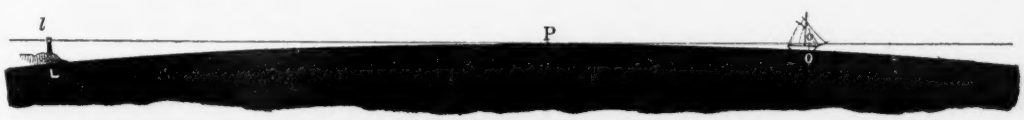

Fig. 12.

HOW TO GET STRONG.

REDUCING FAT.

WE have been asked why we have given attention so fully to the question of reducing weight, as if this were a point of primary importance in athletics. Our reason has been that many who read (*redde*) our former remarks complained that owing to corpulence or excessive weight they found several of the suggested exercises either impracticable or at least very trying and unpleasant. Unquestionably nearly all exercises for increasing the strength of particular muscles are much more agreeable and effective when extra fat has been removed; and since nearly all the methods available for reducing weight are good for the bodily strength generally, we have thought it well to deal with this really important part of our subject before passing to the consideration of systematic exercise, as we shall presently do. This remark as to the effect of fat-reducing processes applies of course with special force to the considerations next to be dealt with, which relate to the forms of exercise best suited for reducing weight.

As a general rule it may be said that the most effective exercises for reducing the weight are those which act most effectively on the respiratory organs. Running for instance is far more quickly effective in this way than walking, though quick walking is a very excellent exercise for the purpose. A steady run taken every morning before breakfast, and another taken every evening shortly before retiring to rest will be found to produce a marked effect on undue deposits of adipose tissue. But here a word of caution

such as we used in the beginning of these papers (in June, 1882) should be repeated. To any one who is thoroughly out of condition, especially if he has long been so, running is rather a dangerous exercise. To run a couple of hundred yards at a moderate rate might do serious injury to a man well advanced in middle age who has long been fat and unwieldy. But even a man of forty not very much out of condition, who has for several years taken little active exercise, ought to be careful how he starts to run more than a few hundred yards, except at a very moderate pace. The best plan is to begin for a week or two with about two hundred yards (unless very heavy) run steadily, but each day a little more sharply. By the time that distance is run at a good sharp pace, the second wind will come easily. Then the distance can be safely increased, until after awhile the morning and evening run is from half-a-mile to a mile in length. It is well to walk out whatever distance one proposes to run (pacing 200 yards for instance at about a yard a pace) and to run home, going then to bedroom or dressing-room to make any necessary changes of dress and to rub down. Although no man should consider himself in decently good condition if he cannot run half-a-mile at a moderate pace without being obliged to change his inside clothing (on account of the freedom with which he has perspired), yet a fat-reducing man is not likely to get through his morning or evening runs without freely perspiring over his work. He should never suffer his wet flannels to remain on him to dry.

Riding and rowing are both good exercises for reducing fat, and tricycling is even better. Boxing, fencing, and single-stick, are also excellent. Bowling and quoits are good, and skittles first-rate. Paterfamilias will find bowling for an hour or two to his boys at their cricket practice, very good exercise for reducing fat, and very pleasant if he chances to have any bowling skill. If he has not, then it would be perhaps rather wearisome. Capital exercise can be obtained by removing from a good-sized room all easily breakable objects, and then playing with a light elastic ball, thrown in such a way against the wall that some activity is necessary to take it, either by catching or with stroke of hand or racket. In an open-air court this is of course much better. And it is hardly necessary to say that lawn-tennis, racquets, and all such exercises are excellent for reducing undue weight. But I am here specially considering those who, being unwieldy, are not particularly anxious to exhibit their unwieldiness before the eyes of friends and acquaintances by taking part publicly in such games as lawn-tennis or cricket. Even rowing is not a very soothing exercise to the obese if the ubiquitous 'Arry welcomes the athlete's exertions with cries of "well rowed fatty" or other uncomplimentary comments on his volume.

Taking too much exercise is a ready way of increasing fat,—paradoxical though it may sound to say so. A man not in good condition will perhaps take two or three days of very active or even violent exercise, drinking so much more than is necessary, on account of the unusual solicitations of thirst, that he can register very little loss of weight. Then he "caves in" for several days, being used up and feverish. During these days he eats drinks and sleeps more than usual, takes less exercise even than he had taken before he thus suddenly roused himself to exertion; and ere he is quite himself again, he finds, on weighing, that he has added to his bulk instead of diminishing therefrom.

In regard then to exercise as to all other methods for reducing undue fat, we advocate moderation on the one hand and steady perseverance in well-doing on the other. Do not go in for great feats of strength or endurance to be followed by long spells of rest, but for steady exercise, continued systematically. If the other methods for reducing weight (all but the medicinal one which is only to be adopted, and that cautiously and with medical advice, at the beginning) be followed steadily and moderately, for weeks and months, not for a few days only, the weight will be reduced safely to its proper amount, the breath and spirits improved, and the value of life notably increased.

(*To be continued.*)

THE COMMA.

By Richard A. Proctor.

THE *Brighton Herald*, in a kindly notice of Knowledge, makes the following remarks on my remark that one of my own favourite *bêtes noires* is the constant custom among compositors of adding a comma after "and" in sentences beginning, "And therefore," "and because," and the like:—

> We think Mr. Proctor is in the wrong. The "therefore" really stands in a parenthesis, which the commas very properly denote. Take as an example the following sentence:—"He called for help, and, therefore, I went to him." It is perfectly clear that the "therefore" is equivalent to an explanatory subsidiary sentence; the full sentence being, "He called for help, and, because he called for help, I went to him." The elision of the explanatory parenthetical sentence is indicated by the "therefore," and for that reason, if for no others, the use of the comma is perfectly justifiable. Mr. Proctor's appreciation of that useful point, the comma, seems to be on a par with that of the sign-writer who, being asked why he put a comma in the middle of a name, declared that he always supposed that "those little curly-cues" were put in for ornament! If otherwise, we would like to know how he justifies the presence of a comma in this sentence, "A few strong-minded women, may try the new dress" (p. 362). We suppose the printers are to be blamed; and the same with regard to the remarkable statement on p. 328 that "The farmer who was with us had several times turned up with the plough large pieces of *camel!*" These eccentricities are scarcely worth notice, but, when Mr. Proctor goes out of his way to assail respectable usages sanctioned by general custom (which, we take it, is the chief standard for testing good or bad grammar), he ought to be twice certain that he has no holes in his own coat. There is enough slovenly writing sent out, without Mr. Proctor using his influence on the wrong side. Let Mr. Proctor say what he likes about the moon, the stars, the earth, or even the sun itself, as to which an error of a few thousand or millions of years make little difference to anybody, but do pray let him leave the humble comma in the enjoyment of its rights and privileges!

Of course the errata referred to in the latter half of this paragraph are no faults of mine,—"camel" for "cannel" occurs in an article by my friend, Mr. W. M. Williams, and was overlooked by him no doubt in correcting proof. But I must confess to some little amusement at the way in which the writer of the above paragraph quietly assumes that my remarks on the use of the comma are the outcome of a careless disregard of the principles of punctuation. Twenty years of careful writing, every sentence penned with the thought of my readers and of their possibly misapprehending my meaning ever present before me, have not, let me assure my friendly critic, resulted in any such feeling about the "humble comma." On the contrary my objection to the set customs of compositors have had their origin in the recognition of the extreme importance of those "little curly-cues." Long experience and attentive observation have satisfied me that of all the marks of punctuation the comma is the most important.

So much might have been recognised from the parts of my Gossip note which the writer in the *Brighton Herald* has not noticed. The constant custom of putting a comma before "which" leads to constant alterations of a writer's real meaning. One writes: "the stars which are of

a ruddy colour are usually," &c.; and the "constant custom" makes him say, "the stars, which are of a ruddy colour, are usually," &c., which is absurd. So with the constant custom of putting a comma before "because." I came only a few days ago on a sentence in one of Mr. Herbert Spencer's works in which his meaning had been entirely altered by such an addition (probably the comma escaped his notice in correcting proof, or, quite possibly, it had been added by that fearful being who, unless strictly warned off, goes over the last proofs, scattering commas over every page apparently with a pepper-castor. The sentence ran somewhat like this as written: "Whales are not classed with fish because they resemble fish; but"—so and so; the constant custom of compositors setting a comma before "because," made Mr. Herbert Spencer state, absurdly, that the reason why whales are not classed with fish is that they are like fish.

With regard to the particular use of the "comma" referred to in the above quotation, I object to that constant custom only when applied to unsuitable cases. Nearly always the words "and therefore" and "and because" may be regarded as forming a single conjunction, almost as though "and" were an enclitic. The sentence given by my critic is a case in point—"He called for help, and therefore I went to him." Here if the "and" were omitted no one would think of adding a comma after "therefore." Adding the "and" as it does not alter the sense gives no reason for introducing a comma which would not be wanted if the "and" were left out. [The compositor is entreated not to put in a "comma" before the "which" in the last sentence.] A fair test of the propriety of the two commas on which the critic insists is obtained by uttering the sentence aloud, as it would be spoken. For it must be remembered that though speech is often slovenly, written language represents speech,—only it should represent carefully-spoken words. Now, no one would think of saying, "He called for help, and"—a pause—"therefore"—a pause—"I went to him." Not only so, but there is hardly a single case in which there ought to be a comma on both sides of the word "therefore" preceded by "and." A comma should often follow the "therefore," as for instance in the following sentences:—"He asked for help in his contest with Watson, so I gave it; and therefore, Watson has never forgiven me"—at least if one wished to dwell somewhat on the fact that it was because of this interference that Watson had remained irreconcilable. Adding the comma emphasizes this particular point. So in the other sentence, if one wished to emphasize the reason, one would add a comma after "therefore." Thus, "Why on earth did you go to him?—Why? Why, because he asked for help; because he and I were old friends; because I thought it my duty: therefore, I went to him." This would be reasonable enough; though note that here the "and" has necessarily dropped out.

But "And, therefore," is simply monstrous—no good writer ever allows such an absurdity to remain, if he can possibly help it. Putting "however" between commas is not quite so bad; though I remember hearing a writer who has perhaps a greater mastery of the art of stating a case than any man living (he has written a good deal in these columns, though anonymously) complain strongly of this constant custom. Here, however, there is some reason for the practice, because (as in this sentence) the word "however" comes in by itself, and might be omitted, like words within parentheses, without making the sense incomplete. In quite a number of cases however the commas are better omitted, especially in long sentences where commas are wanted for more important purposes. Just as the mathematician who has to deal with complicated expressions does not begin to use brackets before he wants them, so is it with the writer who has a long or complicated sentence to deal with. Indeed, as De Morgan long since pointed out, the use of commas, parentheses, dashes, &c., is akin to the use of brackets by mathematicians. I think he even went so far as to say that only mathematicians are likely to punctuate properly; but that is going a little too far.

With regard to the comma before "because," the sense is usually a safe guide. Putting a comma between "and" and "because" is seldom right, though it is a constant custom. The great disadvantage of doing it constantly is that if we do, then, when it is really wanted for a purpose, it does not answer. Thus in the following sentence it is not wanted: "I went to Ventnor, and because I wished to see the lovely neighbourhood I went early." Here the "constant custom" would insert two commas, one before "because," the other after "neighbourhood;" but neither is wanted. (Of course, a comma after "neighbourhood," alone, alters the sense.) But in the following sentence the comma is desirable:—"I hold that men should do their best to advance knowledge; and, because this seems to me an almost sacred obligation, I mean to fulfil the duty to the best of my power." Here, indeed, the comma would only be added for the sake of emphasis: it is not necessary to the sense.

I am aware that many superficial students of style consider that Macaulay solved the whole problem by his use of short sentences; scarce a semicolon to a chapter. With such sentences we need not be careful about commas; we have "points given," so to speak. But Macaulay shirked the real difficulties. Short sentences, like simple Saxon words, are often the best. But just as there is often occasion for the use of long words as the most suitable and weighty (Mr. Herbert Spencer has shown this well in his excellent essay on style), so it is often desirable—much oftener, in fact—to use long sentences. Nothing, indeed, is much more wearisome than the constant iteration of short sentences. When long sentences are in question we have to be careful with our commas, because when they run short we are driven to the use of parentheses, dashes, and so forth, just as the mathematician, when he has utilised ( ) and [ ], has to fall back on { }, and the like, for his bracketing.

CHEMISTRY OF THE CEREALS.

By William Jago, F.C.S.

No. IV. BREAD-MAKING.

I FEEL that here I must be careful not to trench on the subject-matter of the admirable series of papers on the Chemistry of Cookery, by my able colleague, Mr. M. Williams. The difference in the stand-point taken by him and myself will, I think, prevent the two sets of articles seriously over-lapping each other.

The first step in the making of bread is to grind the wheat or other grain into flour; this operation is usually performed by introducing the grain between two flat stones, the upper one of which revolves rapidly on the lower. These stones are made of a very hard grit, and have thei rubbing-faces cut in a peculiar manner. There are first a series of deep radial grooves, whose object is to permit the flour to find its way from the centre outwards; the grain being fed from a hopper to the centre of the mill, and the flour collected from the circumference. In addition to these grooves there are a number of very fine lines cut on the stone's face, in order to produce a cutting surface. After

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the mill has been worked for a short time, it becomes necessary to "dress" or re-cut these lines on the surface of the millstone. This operation requires a considerable amount of skill, and is performed by means of a heavy hammer with a chisel cutting edge, set at right angles to the hilt (something like certain makes of geological hammers). Blow after blow is struck with this implement until the line is sufficiently deepened and a good cutting-edge is produced. There are usually about eight or ten of these lines to the inch. It will be readily understood that a single false blow may undo a lot of careful work by destroying or damaging one of these delicate ridges. At present, in many large mills the stones are dressed by machinery. The cutter consists of a small steel wheel with a number of little diamonds embedded in its circumference. The machine provides for the rapid revolution of this cutter at the same time that it is drawn along the surface of the stone in the direction in which the fine lines run. The diamonds thus dress the stone with remarkable speed and accuracy.

The flour as it leaves the stone is termed "whole meal"; it contains the starch, &c., in the form of very fine particles, while the husk of the grain is simply cut into fragments of sensible size, which in the case of wheat-flour constitute the bran. Brown bread is either made from whole meal or from white flour to which bran has been added. Most people prefer, as a staple article of consumption, bread made from flour deprived of its bran. The miller removes this material by passing the flour through a number of sieves of varying degrees of fineness; in this way the husk is separated in different degrees of coarseness; "bran," "pollard," and "sharps" are names given to three grades of the separated husk—bran being the coarsest, and sharps the finest of the three.

The bran and the white flour produced from the interior of the grain differ considerably in composition, there being much more nitrogenous matter in the former than in the latter, which, on the other hand, contains a much higher percentage of starch. We have here a most important question to consider, because the nutritive value of bread must depend largely on its composition. Speaking generally, we may divide food-stuffs into two groups—first, the nitrogenous or flesh-forming substances, termed by the physiologist "proteids," and, second, the non-nitrogenous or fat-forming and heat-producing substances. The nitrogenous food-stuffs are also efficient as maintainers of animal heat. It is necessary for the healthy continuance of life that both nitrogenous and non-nitrogenous articles of food be eaten. Animals fed exclusively on non-nitrogenous diet speedily emaciate and die; life is, however, much more prolonged in those entirely fed with nitrogenous food. The value of bread as an article of food is greater the more nitrogenous matter it contains, provided the nitrogenous matter is of such a nature as to be readily assimilated by the stomach. From time to time the use of whole-meal bread has been urgently advocated on the score of its greater nutritive power; but the larger proportion of nitrogenous matter it contains is largely compensated by its being practically insoluble. The bran of whole-meal bread is found to be discharged from the system in an almost unchanged condition. From its producing a mechanical irritation of the inner surface of the intestine, it often acts beneficially in cases of chronic constipation.

Dealing first with white flour, a momentary reference may be made in passing to other methods of cooking it than making bread. Dumplings, suet-puddings, &c., consist essentially of flour mixed with suet or other fat, kneaded with water into dough, and subsequently boiled. The chemical changes thus produced are very slight, the principal one being the gelatinising of the starch.

The simplest form of bread is the ship-biscuit, or "hard bread" of the sailor. To make these biscuits, flour with a little salt is kneaded with water into a stiff dough. This is rolled into a thin sheet and cut into biscuits, which are at once rapidly baked in an oven. Although hard, ship-biscuits of good quality have an agreeable flavour, and when soaked in hot coffee and then buttered, form an appetising dish. Bread of this kind is particularly valuable for sea-going purposes, because it may be kept in a dry place for almost an indefinite length of time without undergoing any change.

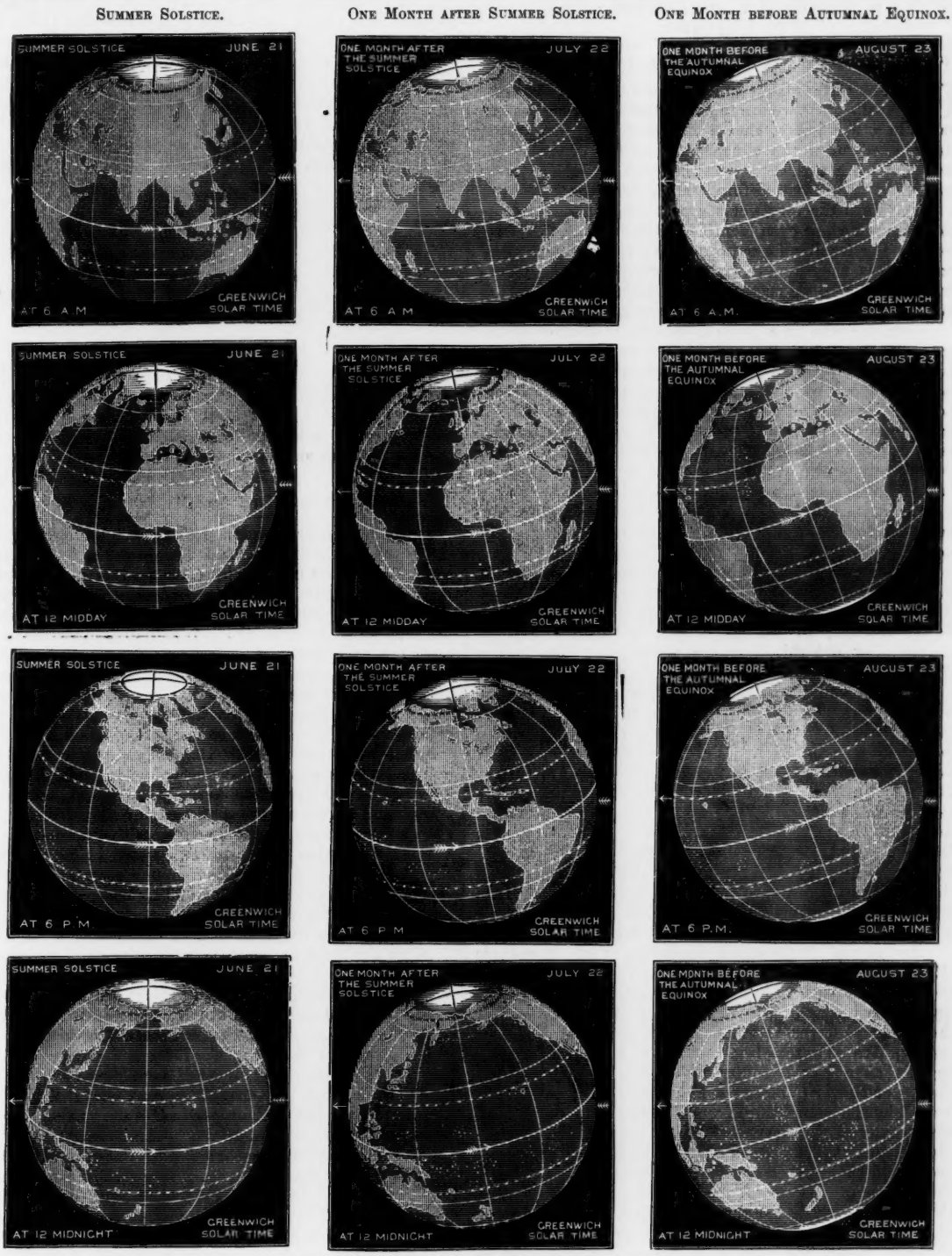
It would be difficult to persuade many landsmen that ship-biscuit at all deserves the name of bread. Perhaps with the sailor, who invariably so terms it except when he uses the phrase "hard tack," the wish is father to the thought. Biscuits, whether ship or otherwise, certainly do not fall within our ordinary definition of bread, which may be described as the flour of wheat or other grain made into a paste with water, then rendered porous by being charged with carbon dioxide gas (formerly termed carbonic acid gas), and next baked by the heat of an oven into loaves with a light brown crust and porous interior.

The first step in bread-making is to secure some means of causing the dough to rise, that is to render it porous by the production within it of gaseous carbon dioxide. It has been already explained how the gluten in wheat flour enables it to produce a highly elastic dough, and thus to retain the vesicular structure resulting from the generation within it of gaseous bubbles. It is here that our knowledge of the constituents of grains becomes useful. If moist flour be exposed to the air, the nitrogenous matter quickly passes into a state of decomposition, and acquires the power of rapidly changing the starch of flour not only into dextrin and sugar, but still further into carbon dioxide and alcohol. This second change is termed "fermentation," and is now definitely ascertained to depend on the presence and growth of certain living organisms in the moistened mass. The sporules or seeds of these bodies are floating about in the air, and dropping on to the moistened flour, develop and multiply, and effect this remarkable decomposition of sugar. Although fermentation plays so important a part in the making of bread, yet it is a far more important element in the production of beer and other liquors from malt. When dealing with them, fermentation can best be considered and explained. The moist flour which has acquired this property is termed "leaven," and, when added to a larger quantity of dough, causes fermentation of the whole mass. The carbon dioxide distends the dough by the production of bubbles, the alcohol is evaporated off during the baking of the bread. The production of alcohol and carbon dioxide by the decomposition of sugar is shown by the following equation:—

$$\underset{\text{Sugar.}}{C_6H_{12}O_6} = \underset{\text{Alcohol.}}{2C_2H_6O} + \underset{\text{Carbon Dioxide.}}{2CO_2}$$

Our next article will continue to deal with the chemistry of bread-making.

We are glad to be able to announce that after three weeks of enforced rest the editor of Knowledge hopes to begin lecturing again (at Eastbourne and Hawkhurst) next week, not at once returning to full work, but hoping gradually to resume his usual working habits. He begs that correspondents will bear with him if there have been delays or omissions. Like the man of whom Mark Twain's correspondent wrote so touchingly, he has "done his level best."



SUN VIEWS OF THE EARTH;

OR, "THE SEASONS ILLUSTRATED."

By Richard A. Proctor.

I GIVE this week our Sun Views for the month, showing the aspect of the earth as supposed to be seen from the sun at six in the morning, noon, six in the evening, and midnight, Greenwich solar time, one month before the autumnal equinox. For comparison, the Sun Views for June and July are repeated.

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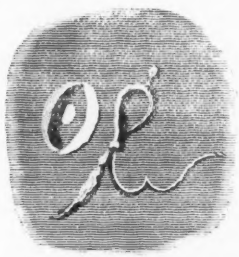
THE MOON IN A THREE-INCH TELESCOPE.

By a Fellow of the Royal Astronomical Society.

THE light of the rising sun continues to creep over the lunar disc, and we are rapidly approaching her eastern limb; in other words, she is now entering that phase denominated full in the almanacs, when the whole of her surface which is turned towards the earth is simultaneously visible. For reasons before stated, however (Vol. II. p. 222), this is the very worst aspect under which details can be examined, or even identified, and we shall, therefore, describe the leading formations which still remain to be spoken of, as they appear when tolerably near the terminator. And here we may note that ring-plains and mountains situated on, or very near, the actual visible limb of the moon, are seen in a much more natural manner by the terrestrial observer than those more centrally placed on her disc; since they are, of course, looked at much more sideways; like our own mountain ranges as we view them from the surface of the earth. The student will be struck with this if he will go carefully round the eastern (and especially the north-eastern) limb of the moon within a day or two of her being full. It is time, however, that we began our examination of such individual objects. as offer points of peculiar interest. Beginning from the south, we shall be struck with the Dörfel mountains (246 in our Map, Vol. II., p. 223), seen in profile on the actual limb of the moon. The three most conspicuous peaks of this tremendous range are believed to exceed 26,000 feet in height. The highest mountain in the world, Mount Everest, in the Himalayas, is 29,000 feet in altitude, but did this bear the same proportion to the earth's diameter that the Dörfel mountains do to the moon's, then would it be 106,079 feet, or more than twenty miles in perpendicular height. In this neighbourhood Phocylides (242) may be looked at as a considerable walled plain, with a flat interior. We, however, mention it here chiefly as a guide to that curious object, Wargentin (243), which looks like an extremely truncated column, some 54 miles in diameter. Webb aptly compares this to "a large, thin cheese." When the moon is eleven or twelve days old, Schickard (239), an enormous walled plain, will repay scrutiny. From north to south this measures some 134 miles, and is nearly as broad, though, of course, it is considerably foreshortened as we view it. The interior is very nearly level, but a three-inch telescope will show the diversity of shade which characterises it. Mersenius (231) is a fine ring plain more than 41 miles across, and contains various small hills, craterlets, &c., quite beyond the power of our instrument. What will strike the young observer is the aspect of its floor, which is convex, like a watch-glass. Just as Fracastorius (372) appears as a bay bounding the southern extremity of the Sea of Nectar (Vol. II., p. 294), so does Letronne (224), formed by the mountains extending from Gassendi, appear at one extremity of the Sea of Storms (Q.) The huge dark plain Grimaldi (272) is nearly 148 miles long by 129 broad, and would have ranked as a "sea" had it been situated near the centre of the moon, instead of close to her limb. Grimaldi is even darker than Plato, and, as we have previously remarked (Vol. II., p. 265,) may often be seen on the dark limb of the moon when illuminated by earthshine. Riccioli (273) is another enormous walled plain, and is very nearly as dark in parts as Grimaldi itself. Just to the south-east of these two last-named formations lie the Lunar Cordilleras (274,) and the D'Alembert Mountains (275), What is probably a portion of this latter chain re-appears as the Rook Mountains (276). Rather further south along the limb, when the moon is nearly thirteen days old, the series of ring plains, Lohrmann (153), Hevelius (154), and Cavalerius (155), offer an interesting spectacle. Hevelius has a convex interior, but by no means so regular as that of Mersenius or does the convexity fill the enclosed area in the same way. Leaving the moon's limb now for the Ocean of Storms we arrive at the most brilliant spot on the whole surface, Aristarchus (148), of which we have spoken before (Vol. II., p. 265), as conspicuous on the dark limb when the moon is young. We had a curious illustration of the extreme brightness of this formation on the occasion in which the subjoined drawing was made (the night of the 15th instant).



Aristarchus and Herodotus. Moon's age 12·86 days.

Huge, black, cumulus clouds were driving at intervals across the sky, and several times when the moon was absolutely blotted out from view in the field of the telescope, Aristarchus continued to shine like a small ill-defined planet. It is difficult or impossible to reproduce this extraordinary lustre in a wood-engraving; it is actually unpleasant to the eye even in a three-inch telescope. The diameter of Aristarchus is twenty-eight miles, and its walls are terraced—albeit the terracing is seen with considerable difficulty, owing to the glare. It has a concave interior with a central mountain—if possible even more brilliant than the internal walls themselves. Its eastern wall extends into a table-land by which it is connected with Herodotus (149). This last-named formation is less than twenty-four miles across, and is very notably darker than Aristarchus. The chief object of interest in connection with Herodotus is the curious serpentine valley or cleft which originates in it, and which was well seen when our sketch was made. Schmidt asserts that this is 1,663 feet deep in places. It enters Herodotus at a point concealed by shadow at the epoch of our drawing.

With this will terminate our description of the moon's surface. As we began by saying, we are not writing a treatise on Selenography, and our object has merely been to invite the attention of the beginner to certain typical Lunar formations, which can be observed with the instrument which has been employed for the purpose of these papers. Our map will in itself supply the student with ample work for a considerable period, inasmuch as it will enable him to identify four hundred of the principal formations on the face of the moon. The possessor of a telescope whom we may have succeeded in interesting in the study of Lunar detail will probably procure Neison's great book on "The Moon," a work containing more detailed information with reference to Selenography proper than any one extant in the English language.

One of the series of descriptive papers of double stars observable with our instrumental means was crowded out at the time by Editorial exigences. It will now appear, and be followed by others on the Sun in a three-inch telescope, and the daylight planets, Mercury and Venus, as viewed with equivalent optical power. In completing these, we shall hope to have furnished the amateur with a

trustworthy guide to the very numerous celestial objects of beauty and interest which are well within the reach of a by no means costly instrument. As a means of perennial amusement and gratification, scarcely anything affords such a return for money laid out as a telescope; and in our survey of the heavens now drawing to a close, we shall have done what we can to show how it may be made to do so.

THE FISHERIES EXHIBITION.

By John Ernest Ady.

V.

TO understand the structure of the sponges in general our best plan would be to trace the life-history of some typical form from its embryonic origin to the adult condition. But this is a matter which is involved in the greatest difficulty, because there are, so to speak, many typical forms, which, so far as they have been studied, present wide differences from one another. Then there are other well-known examples, such as the common fresh-water sponge, which present phases of development now considered to be aberrant.

We are thus driven to the necessity of taking an hypothetical case, and, in following its growth, we shall point out the deviations which lead to the several types which occur in nature.

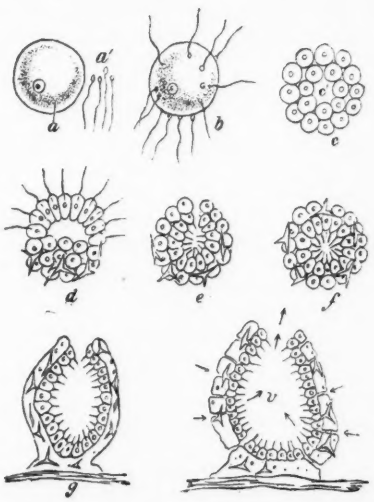


Fig. 11.—Diagrams of the Development of a Sponge: *a*, ovum and *a'*, spermatozoa; *b*, fertilisation of ovum by spermatozoa; *c*, resultant morula, with blastocœle *c'*; *d*, one pole of the embryo ciliated, the other end spiculigerous; *e*, the ciliated pole invaginated into the non-ciliated part; *f*, aperture of embryo closed, showing epiblast with spicules, and hypoblast with cilia surrounding a blastocœle; *g*, the stage *f* fixes itself to a foreign object, and develops an aperture or osculum at the other end; the epiblast fuses into a syncytium, and the hypoblast becomes converted into the endoderm; *h*, the young sponge now develops inhalent pores, which place its ventriculus (*v*) in communication with the exterior. The arrows indicate the course of the currents of water which flow in at these pores, and escape from the exhalent aperture or osculum. (*Original.*)

It is now an all but universally acknowledged fact that, as Martin Barry first pointed out,* cells do not arise *de novo*, as was long ago supposed, but derive their existence from pre-existing cells. To pass backwards in this inquiry, and to ask for an explanation of the ultimate origin of the living cell, and the nature of life, would be equivalent to an entry into the domain of *meta*physical speculation, which we, as *physical* beings, must altogether decline.

We therefore start with certain cells of the adult sponge which become modified at particular periods into rounded masses bounded externally by a firm portion, and containing what is termed a nucleus and a nucleolus within. The whole cell thus formed separates from the parent organism, and is called an *ovum* or female element (Fig. 11, *a*). In yet other cells of the adult sponge, the protoplasm breaks up into small particles, which upon maturity emerge from the so-called *mother cell of evolution*, and acquire peculiar whip-like tails (Fig. 11, *a'*) and clear hyaline heads; these are the *spermatozoa*, or male elements. Ere long, the spermatozoa penetrate the ovum (Fig. 11, *b*), and become absorbed in some mysterious manner. After this *fertilisation* the ovum undergoes peculiar changes; its nucleus (germinal vesicle) and nucleolus (germinal spot) become obscured, and its protoplasm breaks up by repeated division into a mass of nucleated cells, termed a mulberry mass, or, technically, a *morula* (Fig. 11, *c*), within which there is a cavity or *blastocœle*. One half of this mass of cells produce *cilia* (Fig. 11, *d*) or lash-like processes, and by means of these the little embryo swims about. After a time the ciliated cells become tucked (or invaginated) into the other part, somewhat after the fashion of the drawing-in of the tip of a glove-finger, and the stage now arrived at (Fig. 11, *e*) has been termed by Haeckel the *gastrula* stage. Now, it is a curious fact, according to that distinguished observer, that certain sponges (*Gastrophysema*, *Haliphysema*) get no farther than this stage, which (the gastrula) is also a strong argument in favour of the classification of the sponges amongst the cœlenterate animals, instead of with the lowlier unicellular creatures which are classed together as *Protozoa*. Indeed, so very important is this phase of existence amongst animals, that it forms the line of distinction between the *Protozoa* and all the higher groups, which have, on that account been called, collectively, *Metazoa*.

It was a theory of Haeckel's that the mulberry mass of cells (Fig. 11, *c*), formed a central cavity by an internal splitting or delamination, and that an external aperture afterwards appeared to complete the gastrula stage; but the researches of Metschnikoff,* corroborated by F. E. Schulze, have led him† to abandon that aspect of the case, and to agree generally with what has been sketched above, which is an abstract of Metschnikoff's views.

The gastrula now consists of two layers of cells (Fig. 11, *e*), an external layer (epiblast) and an internal layer (hypoblast); within these there is the primitive cavity or *blastocœle*. The mouth now closes (Fig. 11, *f*), and the outer layer of cells gradually becomes fused to form a membrane in which the individual cells cannot be readily distinguished; and in this *syncytium* the skeletal elements begin to be formed. The embryo has now passed into the condition of a young sponge; it fixes itself by one end to some foreign object, and develops an aperture or *osculum* at the other extremity (Fig. 11, *g*). Next, the cells of the body-wall separate at irregular intervals to form pores (Fig. 11, *h*) which can be extemporised at any part of the body, or which may as readily be effaced; and thus a simple sponge is the result, which resembles the adult organism in every essential particular.

* Phil. Trans., Royal Society, London, 1838-9.

* "Zur Entwicke ungsgeschichte der Kalkschwämme, Zeits. für wiss. Zoologie," Bd. xxiv.

† "Die Gastrula und die Eifurchung der Thiere," p. 158.

The ciliated cells of the interior of the body cavity, now called a *ventriculus*, draw in water through the pores or inhalent apertures, and the currents are discharged through the large osculum (Fig. 11, *h*). In this way food is brought to every part of the animal organisation suspended in the water. The currents, of course, are produced by the lashing of the cilia within.

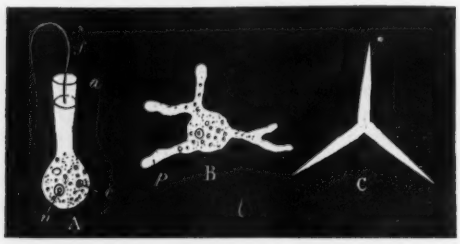


Fig. 12.—*Grantia compressa*, a calcareous sponge. A. Flagellate monadiform cell; *f*, flagellum; *a*, collar; *c*, contractile vacuole; *n*, nucleus. B. Amœboid cell; *p*, pseudopodium. C. Triradiate spicule. (After Carter.)

If now we analyse the body microscopically in detail, we find that the ciliated cells, or, as they are now called, *endodermal* cells, are provided with a collar-like armature, from the centre of which the cilium projects, and that the entire cell, when isolated (Fig. 12, A), bears a strong resemblance to some of the collared monads amongst the flagellated *Infusoria*. It is said that when these cells are fed with coloured particles, such as carmine or Bismarck brown,* the material enters between the cilium and the collar, and thence finds its way into the body of the cell. The outer layer of cells, now denominated the *ectoderm*, which, as we have already stated, becomes fused into a syncytium, is seen to be made up of little particles resembling *Amœbæ* (Fig. 12, B), provided with nuclei and contracting vesicles. Lieberkühn has stated that whilst they seem to be completely fused, they are not so in reality, because, in the case of *Spongilla*, he separated the cells most readily by applying a heat just sufficient to cause protoplasmic coagulation. But this is no argument in favour of their being independent organisms merely associated together, because such a heat would probably be sufficient to dissolve the interstitial cement which held the cells together. Besides, it is a fact well-known to all histological workers, that almost every tissue is capable of dissociation by means of heat, chemical reagents, or ferments; so that the theory of mere coherence through vitality here must fall to the ground. The cells of the sponge, however, are largely endowed with an independent existence; thus, if two *Spongillæ* are brought together, they gradually coalesce to form a single sponge; or, conversely, if a living sponge is cut into pieces, each piece so detached is capable of living and growing. In fact, these occurrences have been taken advantage of by Dr. Oscar Schmidt in his experiments on sponge life, and are now being widely adopted in the commercial fisheries of the Adriatic.

The ectodermal cells of the adult sponge are also said to be capable of ingesting food by themselves; but it is more probable that they derive their nutriment secondarily through the pabulum collected by the endodermic cells.

When a sponge such as that just described developes spicules of an organic material impregnated with carbonate of lime, the spicules are usually tri-radiate (Fig. 12, C), and the sponge is called a calcareous sponge. The *Ascetta primordialis* of Haeckel is a simple form of sponge of this kind; in it we find a flask-shaped body turned upside-down, the neck of the flask is fixed to the substratum, whilst its base remains patent as the osculum. Its walls are composed of only two layers of cells, the ectoderm and endoderm; and in the former, which is in form of a syncytium, the tri-radiate spicules of carbonate of lime are scattered. These spicules are concentrically deposited, and form a firm basis upon which the superstructure is supported. Some of the endodermal cells become converted into the mother cells of the spermatozoa; whilst other cells of either layer are changed into ova, and thus we are brought to the commencement of the cycle of changes described.

* It is best to use Bismarck brown or Vesuvin, as the living organisms become stained without being killed. Carmine usually paralyses delicate organisms.—J. E. A.

Messrs. R. Clay, Sons, & Taylor, of Bread-street Hill, E.C., have purchased the *Pictorial World*, with the intention of carrying it on under such new and improved arrangements as are likely to secure the success which its present large circulation and popularity ought to put beyond a doubt.

Thunderstorm.—Telegrams from Geneva, dated the 15th inst., speak of a very violent thunderstorm as having occurred in the Jura on the morning of that date. Several houses are reported to have been struck, and villages set on fire, whilst the telegraphic and telephonic service was deranged. The centre of the storm seems to have been about Neuchâtel, where for some twenty minutes the sky is reported to have been in a continual blaze.

Telephone Wires and the Public.—On Saturday week, in the City of London Court, before Mr. Commissioner Kerr, an application was made by Mr. G. Kebbell, solicitor, Seething-lane, on behalf of Mr. German, the freeholder of land at Bow, for an order by way of injunction restraining the United Telephone Company and directing them to remove certain posts which they had erected on his property, as well as the wires suspended therefrom. The proceedings, as given in the daily press, were somewhat amusing, as will be seen from the following report:—Mr. Scott, barrister, for the defendant company, contended that they had obtained leave from the lessees of certain parts of the land to erect the posts. Mr. Kebbell denied this, and said that the posts were really placed on the plaintiff's land, over which the lessees had a right of way, and that the wires were beyond doubt suspended across the land in question, which was unoccupied. Mr. Scott: Your Honour knows that it has become a custom for telephone companies to place their wires from house to house, and few people object, as it is a matter of public convenience. His Honour: That cannot give the companies a right to put their wires across any man's land. The law is that an owner is entitled to the enjoyment of everything between his land and the heavens. Why does not the plaintiff cut the wires? Mr. Kebbell: That is just the difficulty. We are afraid that if we did so the wires would fall on other people's land and endanger life. His Honour: But you would not be liable to a charge of manslaughter. Mr. Kebbell: Without discussing my client's legal position, I could not allow him to take a course by which life might be imperilled. His Honour: No doubt. The matter had better stand over till the hearing, and I promise that you shall not be prejudiced by the delay. The case was accordingly adjourned.

"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

All Remittances, Cheques, and Post Office Orders should be made payable to MESSRS. WYMAN & SONS.

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NO COMMUNICATIONS ARE ANSWERED BY POST, EVEN THOUGH STAMPED AND DIRECTED ENVELOPE BE ENCLOSED.

LIGHT FROM FLOWERS.

[900]—Under the head of "Singular Phenomenon" [882] in KNOWLEDGE of July 27, which I happened not to see till two days ago, your correspondent S. Ingham has revived, in a very pleasant way, the recollections of my early years; for I have been for more than half a century acquainted with the occasional notices of this strange appearance which are given in the books of the day, or in older works, and have frequently watched for it, though always unsuccessfully; while in modern times it seems to have passed into undeserved oblivion. As far as I recollect, it was always mentioned as connected with red, and perhaps yellow, flowers—for the marigold was, I think, associated with the geranium; and it was said to be visible in the dusk, and in warm weather. The only book referring to it on which I can now lay my hand is Forster's "Perennial Calendar" (1824), where, under the heading of May 21, is the following not very satisfactory description :—"Among atmospheric phenomena to be noticed at this time of year, we may mention pale lambent light of an electric sort, which plays of an evening in fine weather about the leaves of plants, and of which an account will be found in Forster's 'Atmospheric Phenomena,' third edition, and in the journal subjoined to that work, under May 21, 1808." To the book thus referred to, I have no access at present, but probably some of the readers of KNOWLEDGE may be more fortunate, and may be induced to give us the benefit of a search; in fact the subject is so curious and inexplicable, that it well deserves a closer and more extended investigation, the results of which, with the Editor's kind permission, might appear in these pages. It may be feared that the most favourable season for observation is past, but from Mr. Ingham's letter it is evidently not confined to the spring. In the meantime, as we have so little account of details, I would suggest the following points as deserving of attention :—the character of the light—whether a general haze, or a defined brush or spark; its persistency, or the frequency of its emission; its brightness; length; direction (horizontal or otherwise); colour; and how far it is affected by the presence of the finger or any other body introduced into the region which it occupies. It may be observed that this strange phenomenon has no connection with the sudden and rapid combustion of volatile oil, which may be produced by the application of flame to the stems of the fraxinella while in blossom—a curious experiment which I have repeatedly tried, and which is of a far more intelligible nature. T. W. WEBB.

WART-CHARMING.

[901]—My father, the Rev. John Webb, who died in the year 1869, aged nearly 93 years, possessed this curious power in a remarkable degree. I have heard him describe the way in which, when a young man, he became conscious of it, from touching, for mere amusement, a wart on a child's eyelid with a finger moistened from his tongue, and saying that it would go away. Great was his surprise, as well as that of others, to find that his prediction was soon verified. After that time he exercised this power whenever opportunities presented themselves, and with great success. On one occasion, as he was passing on horseback through a turnpike-gate, he noticed that the arm of a woman who was washing there was covered with warts, which were bleeding from the nature of her work. He touched them and passed on. The next time he saw her, he found they were all gone, though such an inflammation had attended their departure that she thought she should have lost her arm. I have, from time to time, exercised the same power with success. On one occasion I gave the little daughter of a friend, whose hand was much troubled with these excrescences, a small bottle of water tinted with some colour, desiring that each wart should be touched with the wetted cork; this, however, having failed to produce any effect, I made her give me her hand through a nearly-closed door, her back being turned at the same time, and slightly pricked each wart with the point of a penknife. This was followed by their entire disappearance. My impression is that, provided the patient has confidence in the process, anything that affects the imagination sufficiently will produce the result—so surprising and so little understood is the connection between the body and the mind. Truly, we are "fearfully and wonderfully made!"

T. W. WEBB.

GNAT POISON.—WART-CHARMING.

[902]—As a subscriber to your valuable periodical from the start, permit me to offer this communication. Speaking of Aphides in your last issue, Mr. Henry J. Slack thus writes :—"It is supposed that to facilitate a flow of the plant's juices, they pour in a poisonous fluid as gnats do into our bodies." Now, it so happens that very many years ago, and long before I ever hear of the theory that the poison of mosquitoes facilitated their deglutition of blood, I made the following experiments in the West Indies. 1. I permitted one to settle on the back of my hand and insert her proboscis (of which process I should have been unaware had I not been observing it), and then put a stop to her greediness by a slap from the other hand. No poisoning ensued, nor any other perceptible effect. 2. I permitted others to draw blood to various extent short of repletion, killed them in like manner, and the result was the same. 3. I then suffered others to gorge themselves and fly away, and was invariabl poisoned. I wondered at the time at this kindly provision of nature, and though a generation has since passed away, I wonder no less still.

Many years ago a son of mine had a number of warts on his hands, and was told by a countryman that he could get rid of them by cutting a sod in a certain way, rubbing the warts with the under side of it, and then hiding it while no one was looking on. The result being entirely satisfactory, a sister of his then tried the recipe, but it failed completely. My own experience is this—as long as I was at a boarding-school I was troubled with many, and used various applications to get rid of them, but after I had been at home for about three months they all went away of themselves; change of diet, in this case, evidently effecting the cure.

Accept my congratulations on the success of KNOWLEDGE; also on the able way in which you have dealt with certain parties whose mental faculties are evidently polarised, and believe me, yours faithfully, AN M.D. OF FORTY YEARS' STANDING.

May 21, 1883.

MAGIC SQUARES.

[903]—G. S. has sent you (888, Vol. IV., p. 61) "a very complete magic square," which combines most of the properties claimed (233, Vol. I., p. 274) for Snart's "climax to odd squares," with others to be found in Corn. Agrippa's talismanic square (depicted in the 3rd figure, Vol. I., p. 100). Now, first as to Mr. Miles' climax with Snart's square. Bachet never published a square of 49 cells; but his principle applies to the formation of Agrippa's square (2nd figure, Vol. I., p. 100). This has not the 24 ways of reading 175 about the centre which Snart's square has, nor the other two noticed. But Agrippa's square is so perfectly magical that we get 175 on summing up the parallel lines made through 22, 48, 18, 37, 14, 33, 4; 5, 24, 43, 20, 39, 9, 35; 30, 7, 26, &c., in all 7; so through 22, 27, 12, 7, 44, 39, 34; 5, 49, 37, 32, 27, 10; 30, 25, 20, 8, 3, 47, 42, &c., in all 7; so through 22, 42, 6, &c.; 5, 18, 31, &c.; 30, 43, 14, &c., in all 7; so through 22, 11, 49, &c.; 5, 36, 25, &c., in all 7; 22, 29, 36, &c.; 5, 12, 19, &c., another 7. Thus there are 35 ways; or, going upwards, there are 7 of the series, 22, 40, 2, 20, &c., and of 22, 9, 45, &c., of 22, 34, 39, &c., 22, 3, 33, &c.—or 28 more, for 22, 28, 27, &c., are already reckoned.

Next, as to G. S.'s "very complete square." Agrippa's square of 81 cells has not the 24 ways of making 369 about the centre as in G. S.'s square. But there are 9 series parallel to 37, 30, 23, 16, 9, 74, 67, 60, 53; 9 parallel to 37, 71, 15, 40, &c.; 9 parallel to 37, 63, 80, 16, &c.; 9 parallel with 37, 43, 72, &c. These yield 36 ways, and there are many other ways of getting the same result; besides the centre square of nine cells totals 365, and is also magical.

The adjoining square of 81 cells has not the 24 variations exhibited in G. S.'s square, but it has all its other properties, with the addition of 360 other ways of obtaining a summation equivalent to

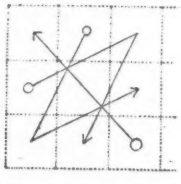
XUM

a side, by taking three consecutive numbers in each of three lesser squares of nine cells, horizontally or vertically, exclusive of his, which must include the centre cell. There are 62 more variations taking one or other of the two diagonals in each small square in combination with one or other of the diagonals in two other smaller squares. Numerous other variations may be made combining three contiguous numbers in each of three smaller squares: thus, three numbers, taken horizontally in one, vertically in another, and diagonally in the third,—35, 28, 33, with 20, 25, 24, and 65, 68, 71; or 12, 14, 16, with 40, 39, 44, and 67, 68, 69, without any reference to the centre cell. Again, the whole square is "tessellated," *i.e.*, is made up of nine lesser squres of nine cells each, each lesser square taken separately being itself a magic square.

31	36	29	76	81	74	13	18	11
30	32	34	75	77	79	12	14	16
35	28	33	80	73	78	17	10	15
22	27	20	40	45	38	58	63	56
21	23	25	39	41	43	57	59	61
26	19	24	44	37	42	62	55	60
67	72	65	4	9	2	49	54	47
66	68	70	3	5	7	48	50	52
71	64	69	8	1	6	53	46	51

		4	9	2
				7
				3
				8

G. S. concludes by remarking that a very little investigation will show the principle upon which his figure is constructed. I question whether this will satisfy most of your readers. My construction is simple. The eight small square is Agrippa's model for all his odd squares. The mean of the progressive numbers is put in the centre, the first term below and the last above the centre. If n represent the number of cells in a side, then the whole series is divided into batches of n terms. The first batch, commencing with 1, is placed in order downwards and diagonally.



On a number of this batch leaving the bottom of the square, it is transferred to a corresponding square at the top, vertically above; should it run out on the right side, it is transferred to the corresponding horizontal cell on the left hand side. The first of the second batch is placed two cells below the last term of the first batch, and the diagonal system continued. Should the first or any other of this batch fall without the square, it is brought in as before explained. The first term of the third batch is placed two cells below the last of the second, and so on. Thus the eighth square was formed. The other squares are arranged in accordance with it. The whole series, through 1, 2, 3 . . . . . to 79, 80, 81, is divided into nine sets, 1, 2, 3, &c., 9; 10, 11, &c., 18; 19, 20, &c., 27, &c. The first set is placed in the square corresponding with the cell in the small square represented by 1, *i.e.*, middle of bottom row. The next set is put in the square corresponding with 2, *i.e.*, the right upper corner, and so on. What Agrippa calls the seal or character of this square (dedicated to Saturn) is really the direction in which their numbers are placed, as in figure. J. O. M.

CURIOUS STRUCTURE IN THE SQUIRREL.

[904]—After removing the skin of a common squirrel, I was struck by observing two thin flaps of muscular tissue extending from the superior part of the fore-arms to the region of the floating ribs; this flap formed part of the muscle of the back, and was open to the front and connected with the intercostal muscles by some fine, tendonous threads. The flaps were partly distended when the creature was lying on its back and immersed in water, and were capable of sufficient distension to allow three of my fingers to be placed in the hollow formed. Not having noticed such a construction in other animals, I wondered whether it was the rudiment of the wing (so to speak) of the flying squirrel, which I am disposed to think it is. It might be described as a huge armpit.

Geo. Combe Williams.

[Mr. Williams's interesting letter was sent in May, but unfortunately was mislaid.—R.P.]

PARCEL POST PROBLEM.

[905]—*Determine the shape and cubic contents of the largest package which can be sent by the parcel post, supposing the length of a cylinder or solid of any other form to be the maximum distance in a straight line between any two points on its surface.*

The shape of the parcel must be that of the volume common to a sphere and a right circular cylinder, the axis of which passes through the centre of the sphere. Let x = radius of sphere

y = radius of cylinder.

$$\text{Then volume common to both} = \frac{4\pi}{3} \cdot \left\{ x^3 - (x^2-y^2)^{\frac{3}{2}} \right\}$$

$$\text{and } 2x + 2\pi y = 6$$

$$\therefore x^3 - (x^2-y^2)^{\frac{3}{2}} = \text{a maximum.}$$

Eliminating dx, dy from the differentials of these equations, we get

$$\pi\,(x^2 - x\sqrt{x^2-y^2}) = y\sqrt{x^2-y^2}$$

or dividing by y^2, putting $\frac{x}{y} = z$, and reducing

$$z^3 - \frac{\pi^2-1}{2\pi} z^2 - z - \frac{1}{2\pi} = 0$$

$$3x^2 - 3x\sqrt{x^2-y^2} + 3y\frac{dy}{dx}\sqrt{x^2-y^2} = 0$$

$$\frac{dy}{dx} = \frac{1}{\pi}$$

Putting for π its value, and solving the equation (which has only one real root), we get

$$z = \frac{x}{y} = 1{\cdot}9625$$

$$\text{also } x + \pi y = 3$$

Whence length of parcel $= 2x = 2{\cdot}307$ feet.

" girth " $= 2\pi y = 3{\cdot}693$ do.

$$\text{Contents} = \frac{4\pi}{3} \cdot \left\{ x^3 - (x^2 - y^2 1^{\frac{3}{5}} \right\} = 2{\cdot}333 \text{ cubic feet.}$$

$= 2\frac{1}{3}$ do. H. F.

[H. F. also sends the correct solution of the problem dealt with at p. 76.—R. P.]

LETTERS RECEIVED, AND SHORT ANSWERS.

A. W. Should not care to publish such wonders till I had seen them myself, and tested pretty closely.—Minnie. Saturn is in Taurus.—J. D. VdS. Fear I can only offer you the Paradox Column; but I would point out, in a note, where your trisection of any angle by simple geometry was invalid, or for what reason it failed to solve the insoluble.—A. T. Fraser. Prefer not to open a vexed and vexing question.—A Lady Mathematician. "Mad Tom" was joking, of course. Non-Euclidean mathematics may be described as mathematics based on axioms inconsistent with our conceptions. A new arithmetic might equally well (as indeed Clifford, Helmholtz, and others suggested) be based on the axiom that 2 and 2 make three, which in some universe unknown to us, they may do. But we may wait before we give time to such new arithmetic or geometry until the unknown universe to which they belong begins to loom above our intellectual horizon.—G. G. Chisholm. Cannot say; but have great difficulty in finding space for all which I should like to give in these columns.—W. H. B. Rannie. Quite impossible to bring out the Star Maps again in Knowledge—it would be unfair to a great number of our readers, who have already had these Star Maps. The great bulk of our first subscribers must (so far as can be judged) be with us still.—Jas. E. Rattle, M. Molyneux, D. E. H. R., Renfrew, Gravesend Doctor, and others. Think it best to insert no more prescriptions for Cholera patients.—Jas. J. Hill. The problem is insoluble in that form, the velocity of a running stream depending on other matters than the fall.—Bank. The star atlas you mention must be imperfect if it fails to show you to what part of the star sphere the earth's axis points, southwards. There is no conspicuous star there, but the place is in the constellation Octans, shown in the middle of the twelfth map of my School Atlas.

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

By Richard A. Proctor.

PART XIII.

LET us consider the method applied in our last. One condition shows us that the point we seek *must* lie on a certain curve; another condition shows us that the point *must* lie on another curve. Therefore, the point we seek must lie at some intersection of the two curves. If there are more intersections than one, the problem has more solutions than one; if there is but one intersection, there is but one solution; if, lastly, the curves do not intersect, the problem is insoluble.

Let us take, as another instance, the following problem :—

Ex. 20.—*Let A B (Fig. 30) be a given straight line, C a given angle, D a given point within the given circle E F G. It is required to determine a point at which A B shall subtend an angle equal to the angle C, and which (point) shall be the bisection of a chord through D to the circle E F G.*

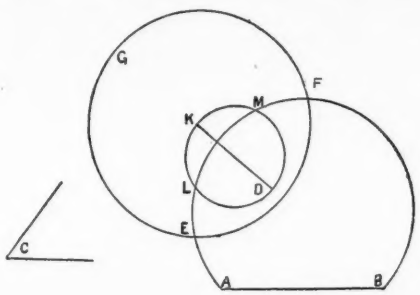


Fig. 30.

In order that A B may subtend an angle equal to C at the required point, this point must lie, we find (as in Ex. 17), on the arc A E B, containing an angle equal to the Angle C.

Again, in order that the required point may be the bisection of a chord through D to the circle E F G, this point must lie, we find (as in Ex. 18), on the circle L K M, which has for diameter the line joining D with K the centre of the circle E F G.

These two loci—viz., the arc A E B and the circle L M K, determine by their intersection the points which satisfy the required conditions. There may be two points, as in the case illustrated by our figure; or one point, if the circle L M K *touch* the arc A E B; or the two loci may not intersect, in which case the problem does not admit of solution.

We have supposed that the point is required to lie above A B. If not, then an arc equal in all respects to A E B, but applied on the opposite side of A B, would include other points satisfying the first condition of our problem. It might happen that the circle L M K intersected the latter arc, instead of, or as well as, the arc A E B. Such point or points of intersection would also supply a solution of the problem.

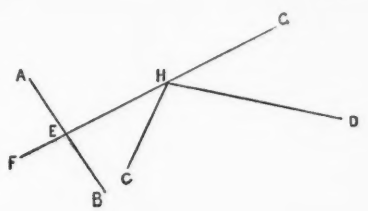


Fig. 31.

Problems in maxima and minima also involve very frequently the discussion of loci.

Suppose, for instance, that the following problem is given :—

Ex. 21.—*A, B, C, and D (Fig. 31) are four fixed points. It is required to determine a point equidistant from A and B, and such that the sum of its distances from C and D shall be a minimum.*

In this case we first find the locus of points equidistant from A and B. This, as in Ex. 18, is the line F G drawn at right angles to the line A B, through its bisection E, Fig. 31. We have, then, to find a point in F G such that the sum of its distances from C and D may be a minimum. We find (as in Ex. 11) that the point must be so taken—as at H—that the lines from C and D to it shall make equal angles (C H F and D H G) with the line F G.

To take another simple instance, suppose we had the following problem :—

Ex. 22.—*A triangle is constructed on a given base A B (Fig. 32), and with a vertical angle equal to the angle C, to determine its figure that its area may be a maximum.*

Here we first inquire what is the locus of the vertices of all the triangles which can be constructed on the base A B with a vertical angle equal to the angle C. We find, as in Ex. 17, that the locus is the arc A D B, containing an angle equal to the angle C.

After this we can find no difficulty in determining the triangle of maximum area. The vertex must clearly lie at that point of the arc A D B which is farthest from A B; and D, the bisection of the arc, is obviously the required vertex. The student will at once *see* this; but perhaps he may find a little difficulty in proving it. We leave this part of the problem to him as an exercise, having already

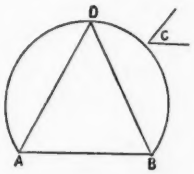


Fig. 32.

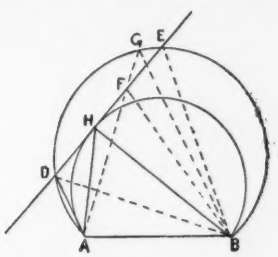


Fig. 33.

examined the treatment of problems of this class. We note, however, that what he has to do is to show that a parallel to A B through D is farther from A B than the parallel through a vertex of any other triangle fulfilling the required conditions; and this will be established if it be shown that the parallel to A B through D is a tangent to the arc A D B.

Sometimes a familiarity with the treatment of problems on loci, serves us in a somewhat more subtle manner, as in the following problem :—

Ex. 23.—*A B (Fig. 33) is a given finite straight line. It is required to show where a point must be taken in the given indefinite line D E, in order that the angle subtended by A B from the point may be a maximum.*

Suppose we take any point, D, at random, in D E, and draw the lines D A and D B. Then, in inquiring whether the angle A D B is a maximum or not, it would be an obvious consideration that the segment of a circle, A D E B, described on A B, contains all the points from which A B subtends an angle equal to the angle A D B. From the point E, therefore, A B subtends an angle, A E B, equal to the angle A D B; and from any point, F, between D and E, it is clear that A B subtends an angle greater than A D B. For, producing A F to meet the arc A D B in G, and joining G B, we see that A F B is greater than A G B (Euc. I., 16), that is than A D B (Euc. III., 27). It is clear, therefore, that we cannot have a maximum so long as the arc described on A B, to pass through the particular point selected in D E, cuts D E in another point. Hence we arrive immediately at the solution of our problem—viz., that the required point, H, is so situated that the arc on A B through H touches the straight line D E.

It is easy to draw a circle through two given points to touch a given straight line. But, strictly speaking, the solution of the above problem is complete without the construction of the circle A H B, since we have assigned a *sufficient* condition for the determination of the required point in D E.

The consideration of problems on loci leads us to another class—or rather two classes of deductions—viz., those in which it is required to prove either that certain straight lines pass through one point, or that certain points (more than two) lie in a straight line.

(*To be continued.*)

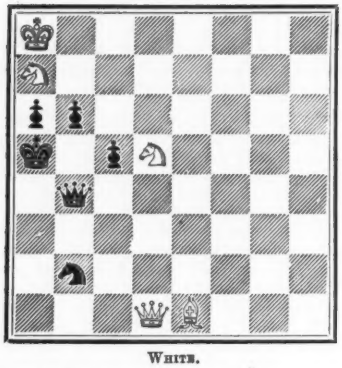
Our Chess Column.

By Mephisto.

PROBLEM No. 93.

By Leonard P. Rees.

Black.



White.

White to play and mate in two moves.

A FINE GAME PLAYED AT NÜRENBERG IN THE SECOND TOURNAMENT BY HERR TARASCH, THE FIRST PRIZE WINNER, IN THE FINAL HEAT OF THE WINNERS.

FRENCH DEFENCE.

White. Herr Tarasch.	Black. Herr v. Scheve.	White. Herr Tarasch.	Black. Herr v. Scheve.
1. P to K4	P to K3	16. B to B5	B to Kt3
2. P to Q4	P to Q4	17. B tks QKt (*d*)	Kt takes B
3. QKt to B3	B to Kt5 (*a*)	18. Kt takes Kt	Q takes Kt
4. P takes P	P takes P	19. P to B5	B to R2
5. Kt to B3	KKt to B3	20. P to B6	B to Kt3 (*e*)
6. B to Q3	Castles	21. R to B2	QR to K sq
7. Castles	B to Kt5	22. QR to KB sq	R to K5
8. B to KKt5	B takes QKt	23. B to Kt3 (*f*)	K to R2
9. P takes B	QKt to Q2	24. P takes P	K takes P
10. Q to Q2 (*b*)	P to B3	25. B to B4	K to R2 (*g*)
11. Kt to K5	Q to B2	26. B takes P	R to KKt sq
12. P to KB4	P to KR3	27. B to Kt5	Q to K3
13. B to R4	P to B4 (*c*)	28. B to B6 (*h*)	R to K6
14. P to KR3	B to R4	29. R to Kt2 (*i*)	R takes P
15. P to Kt4	P to B5	30. R to B3	R to R3

White mates in five.

NOTES.

(*a*) Not commendable. In most close games the B is necessary for the defence of the K side on K2 or Q3.

(*b*) Showing good judgment. If Black now captures the Kt, White would get the open Kt file for his R, which in conjunction with the two B's would soon become dangerous to Black.

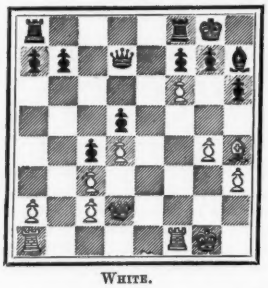
(*c*) Black has his B in a very uncomfortable position; the move in the text does not help him in any way; his only other alternative seems to be Kt takes Kt, which would turn out satisfactorily if BP retook, but White would obtain a superiority as follows:—Kt takes Kt. 14. QP takes Kt, Kt to R2 (Kt to K5 is bad, as after B takes Kt, and P takes B, the Black P on K5 would soon fall). 15. P to B5 (threatening to win the B), P to B3. 16. P to K6, with a good position.

(*d*) White is playing a spirited game. He prefers to continue a doubtful attack to winning a clear P by Kt takes B, and remaining with two B's against two Kt's.

(*e*) P to Kt4 would be bad on account of 21. B takes P, P takes B. 22. Q takes P (ch), B to Kt3. 23. Q to R6. The likely-looking move of B to K5 would result in loss of time, as the B is required for the defence of the BP, *i.e.*, B to K5. 21. P takes P, K takes P. 22. R to B6, R to R sq. 23. QR to KB sq, QR to KB sq. 24. Q to B4, R to R2 (to avoid the threatened loss of the exchange by R to Q6). 25. R to Q6, Q to K sq (as otherwise, B to K7). 26. B to B6 (ch), K to Kt sq. 27. R to Q8, Q to K3. 28. Q to Kt8, and wins.

Position after White's 20th move, P to B6.

Black.



White.

(*f*) To avoid any possible sacrifice of the R for the two P's and the B, and to make the B available for attack.

(*g*) The P cannot be defended by R to KR sq, on account of B to K5 (ch).

(*h*) With the object of playing Q to Kt5.

(*i*) Very fine play indeed, which brings about a forced termination of the game. White threatened to reach the R file *viâ* B2, which Black could not prevent without loss.

(*j*) The ending forms a termination quite worthy of the first prize winner, and is as follows:—31. Q takes R (ch), K takes R. 32. R to R2 (ch), B to R4. 33. R takes B (ch), K to Kt3. 34. R to Kt5 (ch), K to R2. 35. R to R3, mate.

SOLUTIONS.

Problem No. 90, p. 96.

1. Kt to Kt7	K takes R		R takes R
2. Kt to Kt4!	K to K4	Q to R5 (ch)	K to K5
3. Kt to B6, mate.		Kt to B5, mate.	

Or, 2. R to K5

3. Q to B3, mate.

Problem No. 91 we regret to say is incorrect. The author's idea being 1. Kt to B3, R to K4. 2. Q to B4 (ch), B takes Q. 3. Castles, mate. Black can, however, frustrate this artful design by playing 1. R to Q5.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

J. Berger Graz.—Games and problems received; our best thanks for same.

Chess Editor, *Times Democrat*.—We have complied with your request, and hope to be favoured in return.

Leonard P. Rees.—Accept our best thanks for friendly expressions. Problem received with thanks. We hope you will have success in forming an association of the Surrey Chess Clubs. It seems strange that what is possible in Germany—a National Association—should not be attempted in England. The surest road to that end is to form counties associations. You will no doubt have the support of all Surrey players.

Joseph Farrar.—Solution of No. 92 correct.

E. N. Parker.—You evidently did not read Note (*j*) to the game p. 112. It contains the desired information.

B. Hammond.—Problem 92. If K to K7, then P to B4.

W.—Solutions correct. Very sorry you spent so much time over 91. Did you guess the idea?

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